What is claimed is:

1. An article comprising:

a heat source;

a high-efficiency diamond material having a first surface thermally coupled to said heat source.

2. The article of claim 1 further including a heat sink thermally coupled to a second surface of said high-efficiency diamond material.

3. The article of claim 1 wherein said heat source comprises an active electronic device.

4. The article of claim 2 wherein said heat source comprises an active electronic device.

5. The article of claim 2 wherein said active electronic device is formed from at least one of the materials chosen from the group including: gallium, arsenic, aluminum, indium, cadmium, tellurium, boron, phosphorus, nickel, chromium, tungsten, molybdenum, copper, carbon, aluminum.

6. The article of claim 2 wherein said active electronic device comprises a silicon integrated circuit.

7. The article of claim 6 wherein said silicon integrated circuit comprises a microprocessor.

8. The article of claim 2 wherein said active electronic device comprises a microprocessor fabricated from materials other than silicon.

9. The article of claim 3 wherein said active electronic device is formed from at least one of the materials chosen from the group including: gallium, arsenic, aluminum, indium, cadmium, tellurium, boron, phosphorus, nickel, chromium, tungsten, molybdenum, copper, carbon, aluminum.

10. The article of claim 3 wherein said active electronic device comprises a silicon integrated circuit.

11. The article of claim 10 wherein said silicon integrated circuit comprises a microprocessor.

12. The article of claim 3 wherein said active electronic device comprises a microprocessor fabricated from materials other than silicon.

13. The article of claim 1 wherein said contact area is greater than 1 square centimeter but less than 4 square centimeters.

14. The article of claim 1 wherein said contact area is greater than 4 square centimeters but less than 6 square centimeters.

15. The article of claim 1 wherein said contact area is greater than 6 square centimeters but less than 10 square centimeters.

16. The article of claim 1 wherein said contact area is greater than 10 square centimeters.

17. The article of claim 1 wherein said heat source is an aggregate heat source comprising a plurality of individual heat sources.

18. The article of claim 1 wherein the operating temperature of the high-efficiency diamond material component lies between 10 degrees Kelvin and 293 degrees Kelvin.

19. The article of claim 1 wherein said high-efficiency diamond material has a thickness in the range of between about 100 microns and about 2000 microns.

20. The article of claim 1 wherein said high-efficiency diamond material has a thickness in the range of between about 300 microns and about 800 microns.

21. An article comprising:

a heat source;

a high-efficiency diamond material having a first surface thermally coupled to said heat source, wherein said said first surface of said high-efficiency diamond material is mechanically bonded to said heat source using a bonding material having a thermal conductivity greater than 0.1W/cm/°K.

22. The article of claim 21 further including a heat sink thermally coupled to a second surface of said high-efficiency diamond material.

23. The article of claim 21 wherein said first surface of said high-efficiency diamond material is bonded to said heat source with a material having a Young's modulus less than that of diamond.

24. The article of claim 22 wherein said first surface of said high-efficiency diamond material is bonded to said heat source and said second surface of said high-efficiency diamond material said heat sink with a material having a Young's modulus less than that of diamond.

25. The article of claim 21 wherein said heat source comprises an active electronic device.

26. The article of claim 21 wherein said active electronic device is formed from at least one of the materials chosen from the group including: gallium, arsenic, aluminum, indium, cadmium, tellurium, boron, phosphorus, nickel, chromium, tungsten, molybdenum, copper, carbon, aluminum.

27. The article of claim 21 wherein said active electronic device comprises a silicon integrated circuit.

28. The article of claim 27 wherein said silicon integrated circuit comprises a microprocessor.

29. The article of claim 21 wherein said active electronic device comprises a microprocessor fabricated from materials other than silicon.

30. The article of claim 22 wherein said heat source comprises an active electronic device.

31. The article of claim 30 wherein said active electronic device is formed from at least one of the materials chosen from the group including: gallium, arsenic, aluminum, indium, cadmium, tellurium, boron, phosphorus, nickel, chromium, tungsten, molybdenum, copper, carbon, aluminum.

32. The article of claim 30 wherein said active electronic device comprises a silicon integrated circuit.

33. The article of claim 32 wherein said silicon integrated circuit comprises a microprocessor.

34. The article of claim 30 wherein said active electronic device comprises a microprocessor fabricated from materials other than silicon.

35. The article of claim 21 wherein said contact area is greater than 1 square centimeters but less than 4 square centimeters.

36. The article of claim 21 wherein said contact area is greater than 4 square centimeters but less than 6 square centimeters.

37. The article of claim 21 wherein said contact area is greater than 6 square centimeters but less than 10 square centimeters.

38. The article of claim 21 wherein said contact area is greater than 10 square centimeters.

39. The article of claim 21 wherein said heat source is an aggregate heat source comprising a plurality of individual heat sources.

40. The article of claim 21 wherein the operating temperature of the high-efficiency diamond material component lies between 10 degrees Kelvin and 293 degrees Kelvin.

41. The article of claim 21 wherein said high-efficiency diamond material has a thickness in the range of between about 100 microns and about 2000 microns.

42. The article of claim 21 wherein said high-efficiency diamond material has a thickness in the range of between about 300 microns and about 800 microns.

43. An article comprising:

a heat source having an area of at least 1 square centimeter;

a high-efficiency diamond material thermally coupled to said heat source, wherein a thin, low friction, thermally conductive compliant material is interposed between said heat source and said high-efficiency diamond material, and wherein said heat source, said low friction, thermally conductive compliant material, and said high-efficiency diamond material are held together in compression.

44. The article of claim 43 further including a heat sink thermally coupled to a second surface of said high-efficiency diamond material.

45. The article of claim 43 wherein said heat source comprises an active electronic device.

46. The article of claim 44 wherein said heat source comprises an active electronic device.

47. The article of claim 43 wherein said active electronic device is formed from at least one of the materials chosen from the group including: gallium, arsenic, aluminum, indium, cadmium, tellurium, boron, phosphorus, nickel, chromium, tungsten, molybdenum, copper, carbon, aluminum.

48. The article of claim 43 wherein said active electronic device comprises a silicon integrated circuit.

49. The article of claim 48 wherein said silicon integrated circuit comprises a microprocessor.

50. The article of claim 43 wherein said active electronic device comprises a microprocessor fabricated from materials other than silicon.

51. The article of claim 44 wherein said active electronic device is formed from at least one of the materials chosen from the group including: gallium, arsenic, aluminum, indium, cadmium, tellurium, boron, phosphorus, nickel, chromium, tungsten, molybdenum, copper, carbon, aluminum.

52. The article of claim 44 wherein said active electronic device comprises a silicon integrated circuit.

53. The article of claim 52 wherein said silicon integrated circuit comprises a microprocessor.

54. The article of claim 44 wherein said active electronic device comprises a microprocessor fabricated from materials other than silicon.

55. The article of claim 43 wherein said contact area is greater than 1 square centimeters but less than 4 square centimeters.

56. The article of claim 43 wherein said contact area is greater than 4 square centimeters but less than 6 square centimeters.

57. The article of claim 43 wherein said contact area is greater than 6 square centimeters but less than 10 square centimeters.

58. The article of claim 43 wherein said contact area is greater than 10 square centimeters.

59. The article of claim 43 wherein said heat source is an aggregate heat source comprising a plurality of individual heat sources.

60. The article of claim 43 wherein the operating temperature of the high-efficiency diamond material component lies between 10 degrees Kelvin and 293 degrees Kelvin.

61. The article of claim 43 wherein said thin, low friction, thermally conductive compliant material comprises a graphite material.

62. A method for cooling a semiconductor device having a thermal transfer surface area comprising:

growing a diamond film on a substrate in a deposition chamber by reacting gases suitable for diamond deposition in a plasma ignited in said deposition chamber, said plasma disposed adjacent to a growth surface of said substrate such that said plasma extends no further than about 5mm from said growth surface of said substrate;

removing said diamond film from said substrate; and

thermally coupling a first surface of said diamond film to said thermal transfer surface area of the semiconductor device.

63. The method of claim 62 wherein growing said diamond film comprises growing a diamond film having an area larger than said thermal transfer surface area of the semiconductor device and further including:

dividing said diamond film into portions, at least one portion having an area matched to the thermal transfer area of the semiconductor device; and

wherein thermally coupling a first surface of said diamond film to said thermal transfer surface area of the semiconductor device comprises thermally

coupling a first surface of said at least one portion of said diamond film to said thermal transfer surface area of the semiconductor device.

64. The method of claim 62 further including thermally coupling a second surface of said diamond film to a heat sink.

65. The method of claim 62 wherein thermally coupling said first surface of said diamond film to said thermal transfer surface area of the semiconductor device comprises mechanically bonding said first surface of said diamond film to said thermal transfer surface area of said semiconductor device with a bonding material having a thermal conductivity greater than 0.1W/cm/°K.

66. The method of claim 65 further including mechanically bonding a second surface of said diamond film to a heat sink with a bonding material having a thermal conductivity greater than 0.1W/cm/°K.

67. The method of claim 62 wherein thermally coupling said first surface of said diamond film to said thermal transfer surface area of the semiconductor device comprises maintaining said first surface of said diamond film and said to said thermal transfer surface area of said semiconductor device in compression against one another.

68. The method of claim 67 further including maintaining a heat sink in compression with a second surface of said diamond film.

69. A method for cooling a semiconductor device having a thermal transfer surface area comprising:

growing a diamond film on a substrate in a deposition chamber, said diamond film characterized by a composite growth efficiency greater than about 0.003;

removing said diamond film from said substrate; and

thermally coupling a first surface of said diamond film to said thermal transfer surface area of the semiconductor device.

70. The method of claim 69 wherein growing said diamond film comprises growing a diamond film having an area larger than said thermal transfer surface area of the semiconductor device and further including:

dividing said diamond film into portions, at least one portion having an area matched to the thermal transfer area of the semiconductor device; and

wherein thermally coupling a first surface of said diamond film to said thermal transfer surface area of the semiconductor device comprises thermally coupling a first surface of said at least one portion of said diamond film to said thermal transfer surface area of the semiconductor device.

71. The method of claim 69 further including thermally coupling a second surface of said diamond film to a heat sink.

72. The method of claim 53 wherein thermally coupling said first surface of said diamond film to said thermal transfer surface area of the semiconductor device comprises mechanically bonding said first surface of said diamond film to said thermal transfer surface area of said semiconductor device with a bonding material having a thermal conductivity greater than 0.1W/cm/°K.

73. The method of claim 55 further including mechanically bonding a second surface of said diamond film to a heat sink with a bonding material having a thermal conductivity greater than 0.1W/cm/°K.

74. The method of claim 52 wherein thermally coupling said first surface of said diamond film to said thermal transfer surface area of the semiconductor device comprises maintaining said first surface of said diamond film and said to said thermal transfer surface area of said semiconductor device in compression against one another.

75. The method of claim 57 further including maintaining a heat sink in compression with a second surface of said diamond film.

76. A method for cooling a semiconductor device having a thermal transfer surface area comprising:

growing a diamond film on a substrate in a deposition chamber by reacting gases suitable for diamond deposition in a plasma ignited with energy at a frequency greater than 50 MHz and a power of at least 50 watts at a powered electrode in said deposition chamber, said gases maintained at a pressure greater than 20 Torr, said substrate maintained at a temperature greater than about 700°C;

removing said diamond film from said substrate; and

thermally coupling a first surface of said diamond film to said thermal transfer surface area of the semiconductor device.

77. The method of claim 77 wherein growing said diamond film comprises growing a diamond film having an area larger than said thermal transfer surface area of the semiconductor device and further including:

dividing said diamond film into portions, at least one portion having an area matched to the thermal transfer area of the semiconductor device; and

wherein thermally coupling a first surface of said diamond film to said thermal transfer surface area of the semiconductor device comprises thermally coupling a first surface of said at least one portion of said diamond film to said thermal transfer surface area of the semiconductor device.

78. The method of claim 76 further including thermally coupling a second surface of said diamond film to a heat sink.

79. The method of claim 76 wherein thermally coupling said first surface of said diamond film to said thermal transfer surface area of the semiconductor device comprises mechanically bonding said first surface of said diamond film to said thermal transfer surface area of said semiconductor device with a bonding material having a thermal conductivity greater than 0.1W/cm/°K.

80. The method of claim 79 further including mechanically bonding a second surface of said diamond film to a heat sink with a bonding material having a thermal conductivity greater than 0.1W/cm/°K.

81. The method of claim 76 wherein thermally coupling said first surface of said diamond film to said thermal transfer surface area of the semiconductor device comprises maintaining said first surface of said diamond film and said to said thermal transfer surface area of said semiconductor device in compression against one another.

82. The method of claim 81 further including maintaining a heat sink in compression with a second surface of said diamond film.